Module 1: Introduction to Drive Trains

Introduction

A drive train:
- Provides a way to connect and disconnect engine power.
- Provides a means to vary the gear ratio between the engine and the wheels, to meet changing loads and conditions.
- Provides a supplementary braking system.

Basic Components of a Drive Train

- Flywheel is a rotating metal disc mounted to the rear end of a crankshaft designed to even out power surges during power strokes and deliver energy back during other strokes (used primarily on standard transmissions).
- Clutch is a device that connects or disconnects a power source from the part it operates to provide a smooth transmission of torque to working parts in movement (used primarily on standard transmissions).
- Flex plate is sometimes called a flex disc and is positioned between, and used to mount, the engine crankshaft to the torque converter. The purpose of the flex plate is to transfer crankshaft rotation to the shell of the torque converter (used primarily on automatic transmissions).
- Torque converter, a fluid clutch used on automatic transmissions, transfers and multiplies torque from the engine to the transmission.
- Transmission is a component that increases torque by changing gear ratios, permitting a vehicle to move at varying speeds in both forward and reverse. There are two types: manual and automatic.
- Drive shaft is a shaft or tube consisting of universal and slip joints. It transmits power from the transmission to the differential and is sometimes called a propeller shaft.
- Differential is a gear assembly located on the drive axle(s) that transmits power from the drive shaft to the wheels.
- Final drive is the last phase of a power train. It gives final reduction in speed and increase in torque to the drive wheels.

Operation of a Drive Train

- Manual transmission.
  - Power from engine is transmitted to flywheel.
  - Clutch is mounted to flywheel and used for connecting and disconnecting the engine from the transmission.
  - Power or torque is transmitted from the clutch through the transmission at various speeds and loads.
- The power or torque comes out of the transmission to the drive shaft (propeller shaft).
- Drive shaft sends the power or torque to the rear axle differential, through the pinion and ring gear.
- The differential sends the power or torque out to the final drive, by the use of axle half shaft.

Note: The final drive can be a hub or a gear reduction, which transmit the final power or torque to the drive wheels.
Automatic transmission.
- Power or torque is transmitted to the flex plate.
- Power is transmitted to the torque converter through a fluid clutch.
- Power or torque is transmitted from the torque converter through the transmission at various speeds and loads, which can be controlled automatically or manually.

The power or torque comes out of the transmission to the drive shaft (propeller shaft).
- Drive shaft sends the power or torque to the rear axle differential, by the use of axle half shaft.

Note: The final drive can be a hub or a gear reduction, which transmit the final power or torque to the drive wheels.

Working Applications

Working applications of drive trains include:
- Trucks (highway and off-road).
- Industrial and off-road equipment.
- Marine.
- Power generation.
- Agriculture equipment.

Types of Drives

Gear drives.
- Fluid drives.
- Belt drives.
- Chain drives.

Types of Gears

Strap spur gears have straight teeth.  
Note: These gears are loud and used mainly for slow speeds (first and reverse gears).
- Helical spur gear have teeth are cut at an angle.  
Note: Helical spur gears are fairly quiet in operation and have greater strength and durability than straight spur gears because the contacting teeth are longer.
- Herringbone gears are double helical gears with teeth angles reversed on opposite sides.
- Planetary gears, in which the outer ring gear has internal teeth that mate with teeth on smaller planet gears; these gears mate with a center or sun gear.
- Worm gear is actually a screw, and the mating gear has teeth that are curved at the tips to permit a greater contact area and is capable of high speed reduction.

Rack and pinion converts straight motion into rotary motion and vice versa.
- Plain bevel gears permit the power flow to turn a corner, and the gear teeth are cut straight on a line with the shaft.
- Spiral bevel gears permit the power to turn a corner; the teeth are cut at an angle and are used where higher speed and strength are required.
- Hypoid gears resemble the spiral bevel gears, but the driving gear is located below the center of the driven gear.
- Amboid gears resemble the spiral bevel gears, but the driving gear is located above the center of the driven gear.
In order to calculate the gear ratio, you must first count the number of teeth on the driving gear and the number of teeth on the driven gear. The gear ratio can then be found by dividing the number of teeth on the driven gear by the number of teeth on the driving gear.

Example: 75 driven gear teeth/45 driving gear teeth = 1.66:1 gear ratio.

This means the driven (output) gear is rotating 1.66 times slower than the driving (input) gear.

Note: Most transmissions will have more than one driving gear and/or more than one driven gear. To find the gear ratio when there is more than one gear of either or both types, multiply the number of teeth on each driving gear together and the number of teeth on each driven gear together. The gear ratio is calculated by dividing the product of the number of teeth on the driven gears by the product of the number of teeth on the driving gears.

Example:
Driven gears (40 × 62 × 22 × 10) = 545,600.
Driving gears (30 × 40 × 12 × 8) = 115,200.
545,600/115,200 = 4.7361:1.
Gear ratio = 4.7361:1. This means the driven (output) gears are rotating 4.7361 times slower than the driving (input) gears.

Determining Gear Rotation

Rotation is a term used to describe the fact that a gear, shaft, or other device is turning. The direction of rotation is described by comparing it to the rotation of the hands of a clock. As the time progresses, the clock hands move clockwise, or have a right-hand direction of rotation. If the clock hands moved in the opposite direction, they would be moving counter-clockwise or have a left-hand direction of rotation. To determine gear rotation on a transmission, face the front of the transmission and observe gear rotation.

Gears are also used to change the direction of power transmitted. If the drive gear is turning clockwise, then the driven gear will turn counter-clockwise. If the drive gear is turning counter-clockwise, then the driven gear will turn clockwise.

Note: An idler gear is a gear that is placed between a drive gear and driven gear. With an idler gear in place, the driven gear will have the same direction of rotation as the drive gear.

Calculating Gear Speed

Gears are used to change speed. A small gear will drive a large gear more slowly but with greater torque. A large gear will drive a small gear faster but with less torque.

Formula for calculating gear speed:
• To calculate the RPM (speed) of a gear, multiply the RPM (speed) of the other gear times its number of teeth. Then divide that answer by the number of teeth on the gear you’re trying to determine the RPM of, and the result will be the RPM (speed) of the gear.

Example: Find the RPM (speed) of a driven gear with 30 teeth, when the driving gear has 65 teeth and is operating at 150 RPM.
• Driving gear: 65 (# of teeth) × 150 (RPM) = 9,750.
Driven gear: 30.
Therefore, 9,750 divided by 30 = 325 (RPM of the driven gear).
Specialty Tools

Axle-end sockets are used to remove the axle nut on axle hubs.
  Note: Some axle nuts have six sides and some have eight sides. Make sure to use the correct sockets.

Clutch adjusting ring tool is used to adjust the adjusting ring on a pull release clutch, and to maintain the correct amount of clutch pedal free travel.

Clutch alignment tool is used to align the clutch disc’s spline to the spline of the transmission input shaft.

Differential carrier repair stand is used to safely secure the differential carrier for service and repair.

Scan tools are used to retrieve diagnostic information from vehicle computers and to program vehicle parameters and can be a specialized piece of electronic equipment unique to the manufacturer or a PC (laptop computer).
  Note: Fault/trouble codes can vary with the vehicle make and year, and type of drive train and engine. Each manufacturer uses different software and communication adapters to receive and program information for the power train module.

Spring scale (pull scale) is used to measure the rolling torque of transmission and pinion shafts.

U-joint puller is used to remove U-joints from the drive-line.

Checking Fluid Levels

The driver is responsible for checking fluid levels daily.
  • Manual transmission.
    ◦ Check for oil leaks around bearing and PTO covers and any other machined surfaces.
    ◦ Check for oil on the ground, as this would indicate that oil might be leaking through a seal or gasket.
  • Automatic transmission.
    ◦ Check transmission for loose hoses or oil leaks.
    ◦ Check oil level daily and raise oil to operating temperature by letting the engine idle with the transmission in neutral.
    ◦ Check oil level and add oil if level is at or below the bottom line of the HOT RUN or ADD line.
  • Drive axle(s).
    ◦ Check for oil leakage by checking axle housing for leakage at axle seal, yoke seals, and component mating surfaces.

The technician is responsible for checking fluid levels periodically.
  • Manual transmission.
    ◦ Check for oil leaks around bearing and PTO covers along with any other machined surfaces.
  • Automatic transmission.
    ◦ Check transmission for loose hoses or oil leaks.
    ◦ Check transmission oil level at manufacturer’s recommended interval.
  • Drive axle(s)
    ◦ Check axle housing(s) for leakage at axle seal, yoke seals, and component mating surfaces.
    ◦ Check oil level(s) by removing the filler plug and checking that the fluid is even with the bottom of the filler plug. Add oil as necessary.
    ◦ Check and clean the axle housing breather.

  ◦ Check for oil on the ground, as this would indicate that oil might be leaking through a seal or gasket.
  ◦ Check oil levels every 5,000 to 10,000 miles by removing the filler plug and checking that the fluid is even with the bottom of the filler plug. Add oil if necessary.
  ◦ Check manufacturer’s specifications, because each manufacturer recommends checking the oil at different intervals.
Troubleshooting and Failure Analysis

**READY FOR REVIEW**

- Several purposes of troubleshooting and failure analysis.
  - To systematically eliminate potential causes of component failure.
  - To keep repair costs to a minimum.
  - To repair the failure as quickly as possible.

Steps in Troubleshooting

**READY FOR REVIEW**

- Identify the type of work being performed, as this may give you clues as to what components are used more than others.
  - Construction.
  - Industrial.
  - On/off road trucking.
- Listen
  - As the customer describes how the component is malfunctioning.
  - If you are familiar with the component’s operation, the symptoms may tell you where the problem lies.
  - Pose questions in your mind as you listen so you can adequately question the client about the problem(s).
- Verify the problem by operating the component.
  - Operate the component to try to duplicate the problem, and if you can’t duplicate the problem, then it might be intermittent.
- Review the vehicle’s maintenance records.
  - The maintenance history of the vehicle will tell you if this is a repeat problem or if previous repairs may somehow be related to the new problem.
- Organize and record the facts.
  - Using diagnostic flow charts and the service manual, narrow the malfunction to the most probable cause of the failure.
- Perform any tests that are needed to locate the problem.
  - Follow procedures recommended by the diagnostic flow charts or service manual, and rely on your previous experience with this type of problem.
- Make the repair by fixing or replacing the malfunctioning components.
- Verify the repair.
  - Test-drive the vehicle or operate the equipment as you did to “verify the problem.” If the problem does not return, the job is complete.
- Follow-up with the customer within a few days to find out if the problem has disappeared.
Characteristics of Failures

**READY FOR REVIEW**

- Characteristics of drive train failures caused by wear.
  - Abrasive wear occurs when surfaces are scratched, cut, gouged, or grooved.
  - Adhesive wear occurs when surfaces melt and stick together.
  - Corrosive wear occurs when surfaces show signs of rusting, pitting, and scaling.
  - Erosive wear occurs when particles strike and break away smaller pieces.
  - Cavitation wear occurs when vapor bubbles form and collapse, causing removal of surface material.
  - In contact stress fatigue, the surface shows signs of pitting, spalling, and cracking caused by sliding or rolling loads.

- Fretting corrosion is the result of microwelding and pitting that occurs when two surfaces that are held together, rub against each other.

- Characteristics of drive train failures caused by fractures.
  - Ductile fractures are caused by high temperatures and overload, crack begins internally and moves outward; metal fatigue and wear is prominent.
  - Brittle fractures are caused by sudden shock or impact; signs are rough surfaces with little wear.
  - Fatigue fractures are caused over time by part failure, signs are flat, smooth fractures and light color.

Causes of Drive Train Failure

**READY FOR REVIEW**

- Incorrect assembly.
- Defective parts.
- Operator abuse.
- Lack of preventive maintenance.

Shop and Vehicle Procedures

**READY FOR REVIEW**

- Proper procedures when working in the shop.
  - Keeping shop floor and workbenches clean.
  - Storing flammable liquids in a closed steel cabinet that is adequately marked.
  - Storing oily rags in an approved, covered container.
  - Maintaining shop equipment in good working order.
  - Properly tagging and reporting malfunctioning equipment to your instructor.
  - Emptying garbage containers when full.
  - Never using a tool unless you’ve been trained on its operation.
  - Using the right tool for the right job.
  - Keeping tools clean.
  - Storing parts and tools in their proper location.

- Proper vehicle procedures.
  - On the other hand, if the customer finds grease spots on the upholstery or fenders after service has been completed, they will probably think the shop is careless, not only in vehicle care, but also in the quality of their service.

- Additional proper vehicle procedures.
  - Check around the vehicle for objects or personnel before attempting to start a vehicle.
  - Check brakes before operating any vehicle.
  - Check that the garage door is open high enough to allow the vehicle to safely exit.
  - Obey all traffic laws if a road test is necessary.
  - Install fender covers before beginning any shop work, and install seat covers before entering the cab for any reason.